National Renewable Energy Laboratory

Renewable Energy Databases, Information and GIS Tools

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Objective of Talk

Renewable energy databases

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Emission and air quality databases

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Geospatial tools

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Analytic capabilities

Outline

- Renewable energy resource databases
- GIS as a tool for integrating databases
- Examples of value-added products
- Applications to air quality mitigation analysis

Characteristics of Renewable Energy Resources

- **Domestic source of clean energy**
- **Low or no “fuel” cost**
- **Consumption does not deplete supply**
- **Vary over space and time**
- ***Rate* of conversion generally controlled by amount of resource**

Integration of resource data using Geographic Information System tools provides high value to planners and industry

How Assessments are Conducted

- Measurements
- Empirical analyses
- Statistical analyses
- Modeling approaches

Examples of Solar Resource Assessments

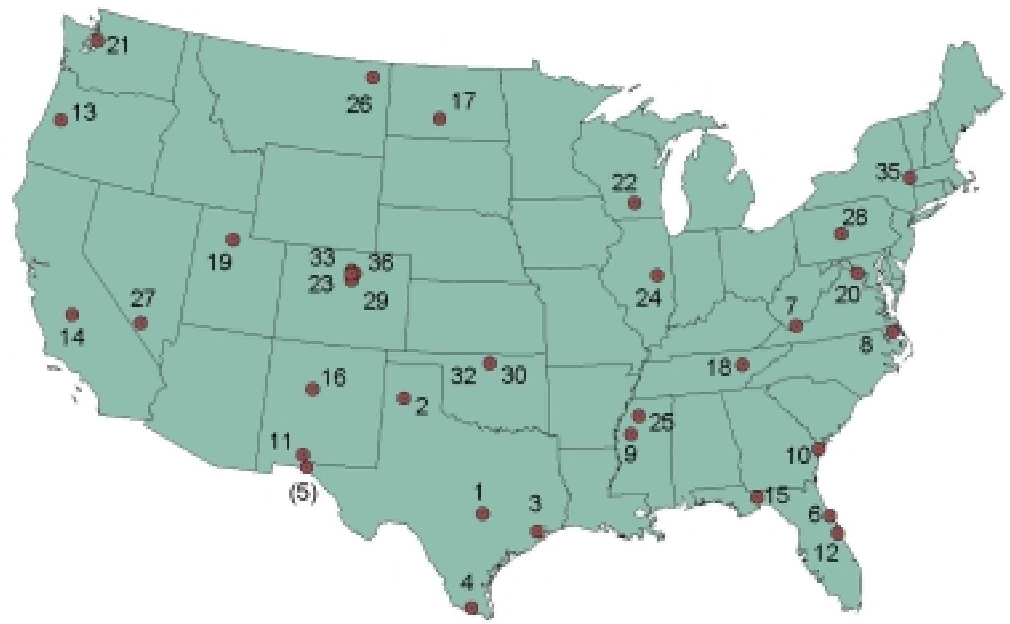
- National measurement programs
- U.S. National Solar Radiation Database (NSRDB)
- Solar radiation data “grids”
- Satellite-derived techniques

National Solar Measurements

INFORMATION ON NATIONAL AND REGIONAL SOLAR MONITORING NETWORKS

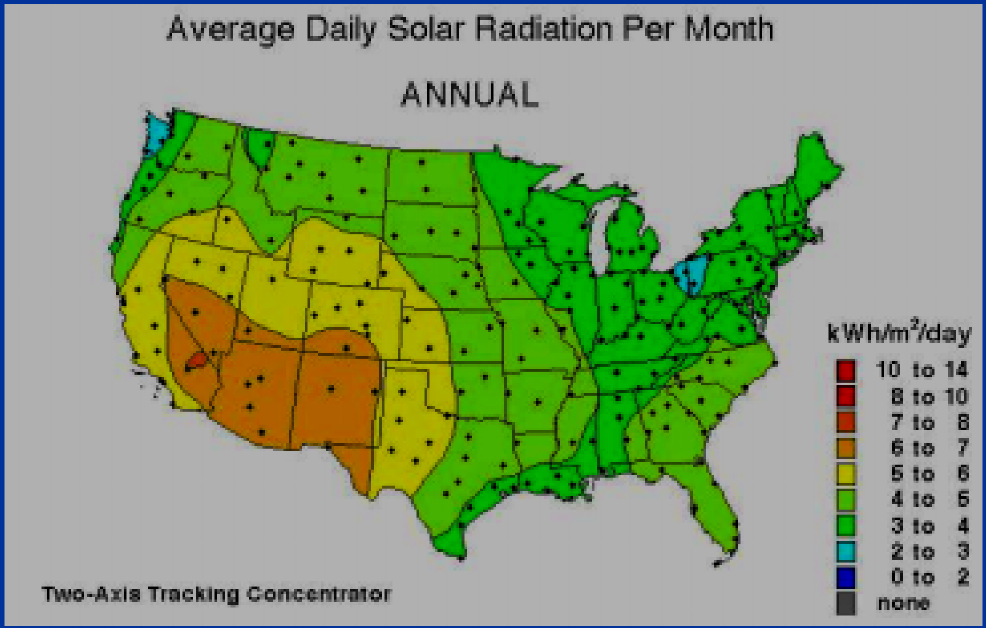
LOCATOR NUMBER	NETWORK	OPERATOR	STATION NAME	N LATITUDE (DEG.)	W LONGITUDE (DEG.)	START of MEASUREMENT
1	CONFRRM	UNIVERSITY OF TEXAS SOLAR LAB	AUSTIN, TX	30.29	97.74	APRIL, 1997
2	CONFRRM	UNIVERSITY OF TEXAS SOLAR LAB	CANYON, TX	34.99	101.9	JUNE, 1997
3	CONFRRM	UNIVERSITY OF TEXAS SOLAR LAB	CLEAR LAKE, TX	29.57	95.09	AUGUST, 1997
4	CONFRRM	UNIVERSITY OF TEXAS SOLAR LAB	EDINBURG, TX	26.3	98.17	APRIL, 1997
5	CONFRRM	UNIVERSITY OF TEXAS SOLAR LAB	EL PASO, TX	31.77	106.5	JULY, 1997
6	CONFRRM/HBCU	BETHUNE-COOKMAN COLLEGE	DAYTONA BEACH, FL	29.18	81.02	AUGUST, 1985
7	CONFRRM/HBCU	BLUEFIELD STATE UNIVERSITY	BLUEFIELD, WV	37.27	81.24	NOVEMBER, 1985
8	CONFRRM/HBCU	ELIZABETH CITY STATE UNIV	ELIZABETH CITY, NC	36.3	76.25	SEPTEMBER, 1985
9	CONFRRM/HBCU	MISSISSIPPI VALLEY STATE UNIV	ITTA BENA, MS	33.5	90.33	JULY, 1985
10	CONFRRM/HBCU	SAVANNAH STATE UNIVERSITY	SAVANNAH, GA	32.03	81.07	AUGUST, 1985
11	CONFRRM/OTHER	SW TECHNOLOGY DEV. INSTITUTE	LAS CRUCES, NM	32.27	106.74	MARCH, 1998
12	CONFRRM/OTHER	FLORIDA SOLAR ENERGY CENTER	COCOA, FL (1)	28.4	80.8	JANUARY, 2000
13	CONFRRM/OTHER	U OF OR SOLAR ENERGY LAB	EUGENE, OR	44.05	123.07	MAY, 1975
14	ISIS	NOAA/ARL	HANFORD, CA	36.31	119.63	MAY, 1995 (2)
15	ISIS	NOAA/ARL	TALLAHASSEE, FL	30.38	84.37	JANUARY, 1995 (2)
16	ISIS	NOAA/ARL	ALBUQUERQUE, NM	35.04	106.62	JANUARY, 1995 (2)
17	ISIS	NOAA/ARL	BISMARK, ND	46.77	100.77	JANUARY, 1995 (2)
18	ISIS	NOAA/ARL	OAK RIDGE, TN	35.96	84.29	JANUARY, 1995 (2)
19	ISIS	NOAA/ARL	SALT LAKE CITY, UT	40.77	111.97	APRIL, 1995 (2)
20	ISIS	NOAA/ARL	STERLING, VA	38.98	77.47	AUGUST, 1995 (2)
21	ISIS	NOAA/ARL	SEATTLE, WA	47.68	122.25	MARCH, 1995 (2)
22	ISIS	NOAA/ARL	MADISON, WI	43.13	89.33	JUNE, 1996 (2)
23	SURFRAD	NOAA/ARL	TABLE MT., CO	40.13	105.24	JULY, 1995 (3,4)
24	SURFRAD	NOAA/ARL	BONDVILLE, IL	40.05	88.37	APRIL, 1994 (3)
25	SURFRAD	NOAA/ARL	GOODWIN CREEK, MS	34.25	89.87	DECEMBER, 1994 (
26	SURFRAD	NOAA/ARL	FORT PECK, MT	48.31	105.10	NOVEMBER, 1994 (
27	SURFRAD	NOAA/ARL	DESERT ROCK, NV	36.62	116.02	JULY, 1995 (2)
28	SURFRAD	NOAA/ARL	PENN STATE U, PA	40.72	77.93	JUNE, 1998
29	SRRL	NREL	GOLDEN, CO	39.74	105.18	APRIL, 1985
30	ARM/SGP CF	USDOE	LAMONT, OK	36.61	97.49	NOVEMBER, 1992 (
31	ARM/NSA	USDOR	BARROW, AK	71.3	-156.68	JULY, 1997
32	ARM/SGP BSRN	NOAA/ARL	LAMONT, OK	36.61	97.49	JANUARY, 1995
33	BSRN	NOAA/CMDL	ERIE, CO (3)	40.05	105.01	JANUARY, 1992
34	BSRN	NOAA/CMDL	BARROW, AK	71.32	156.61	JANUARY, 1992 (3,
35	IDMP	ASRC, SUNY/ALBANY	ALBANY, NY	42.42	73.51	OCTOBER, 1991
36	CMDL	NOAA/CMDL	BOULDER, CO (6)	39.99	105.26	1975
37	CMDL	NOAA/CMDL	MAUNA LOA, HI	19.54	155.58	1976

NOTES:
(1) Eighteen years of data from previous site in Cape Canaveral, FL; 15 km east of present site
(2) Earlier data at or near this site available through the National Climatic Data Center, Asheville, NC
(3) Also designated as a BSRN station
(4) Boulder Atmospheric Observatory, Located near Erie, CO
(5) Earlier data available through the CMDL web site
(6) Located at 325 Broadway (Moved to this location from 30th and Marine St. in 1999)



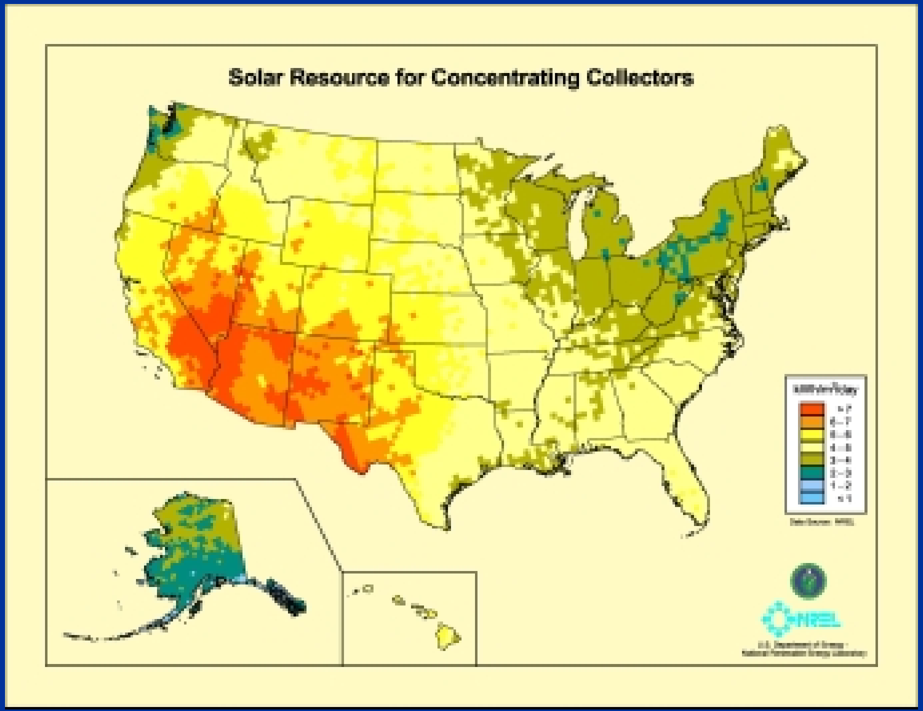
The National Solar Radiation Database

- Hourly data: 1961-1990
- 239 Stations
- Statistical summaries
- Various collector orientations
- 95% of data are modeled

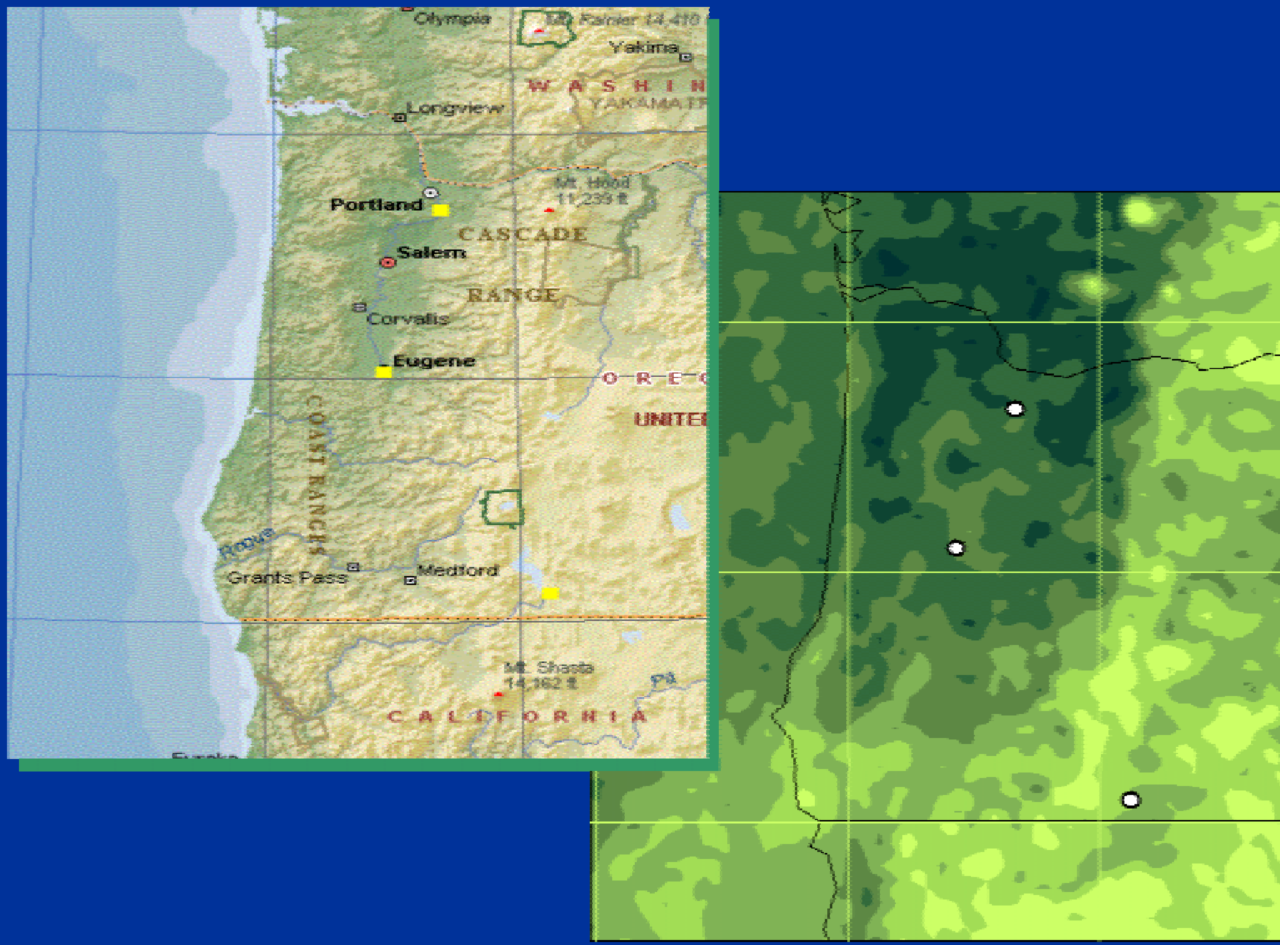


Solar Radiation Data Grids

- 40-km resolution
- Monthly averages: 1985-1991
- Modeled values
- Various collector orientations



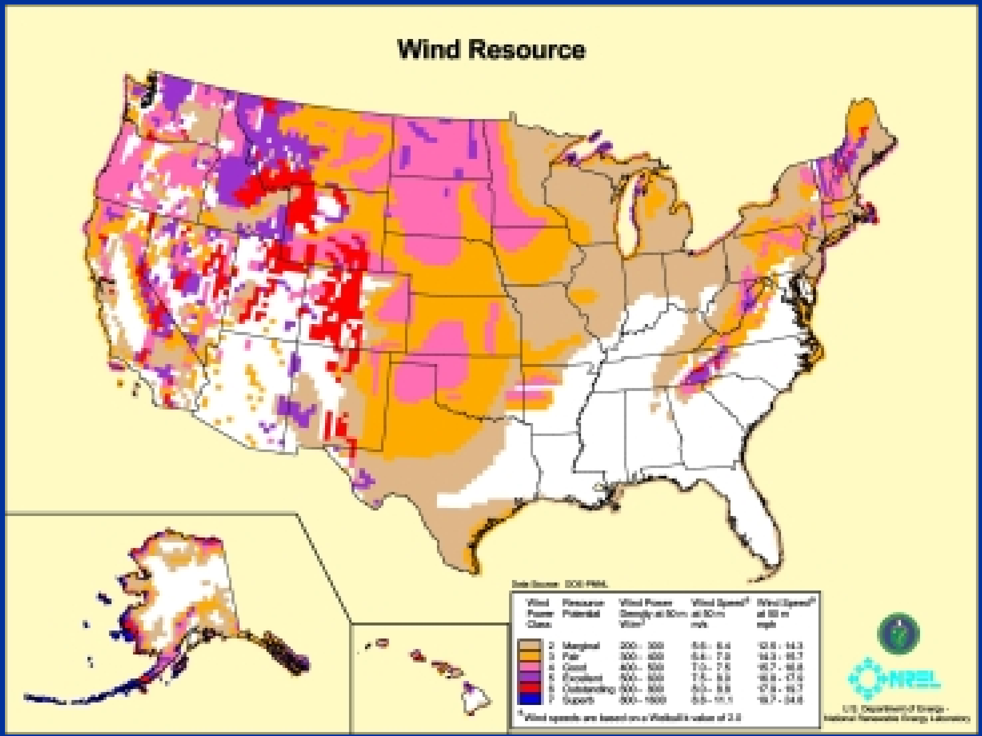
Satellite-derived Solar Data



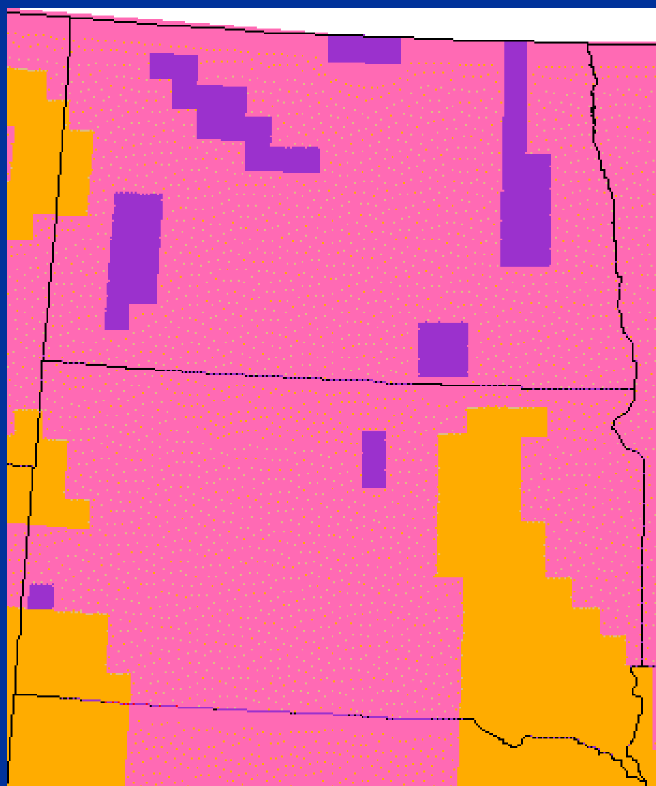
Source: Richard Perez, SUNY/Albany and Frank Vignola, U of OR

National Wind Atlas

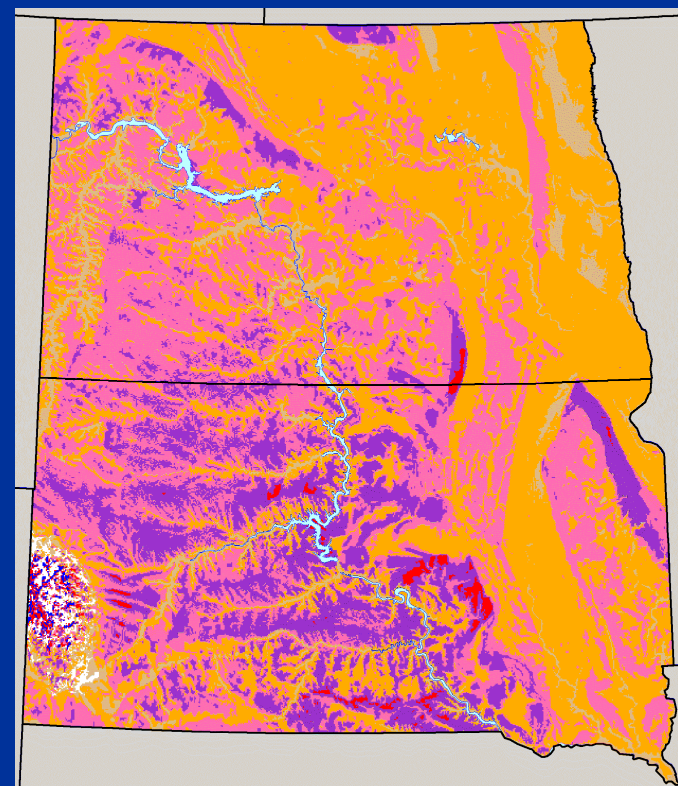
- Produced in 1987 at PNNL
- Approx. 25-km resolution
- Seasonal, annual power classes
- Wind statistics
- Uncertainty analysis



High-Resolution Wind Mapping



1987



2000

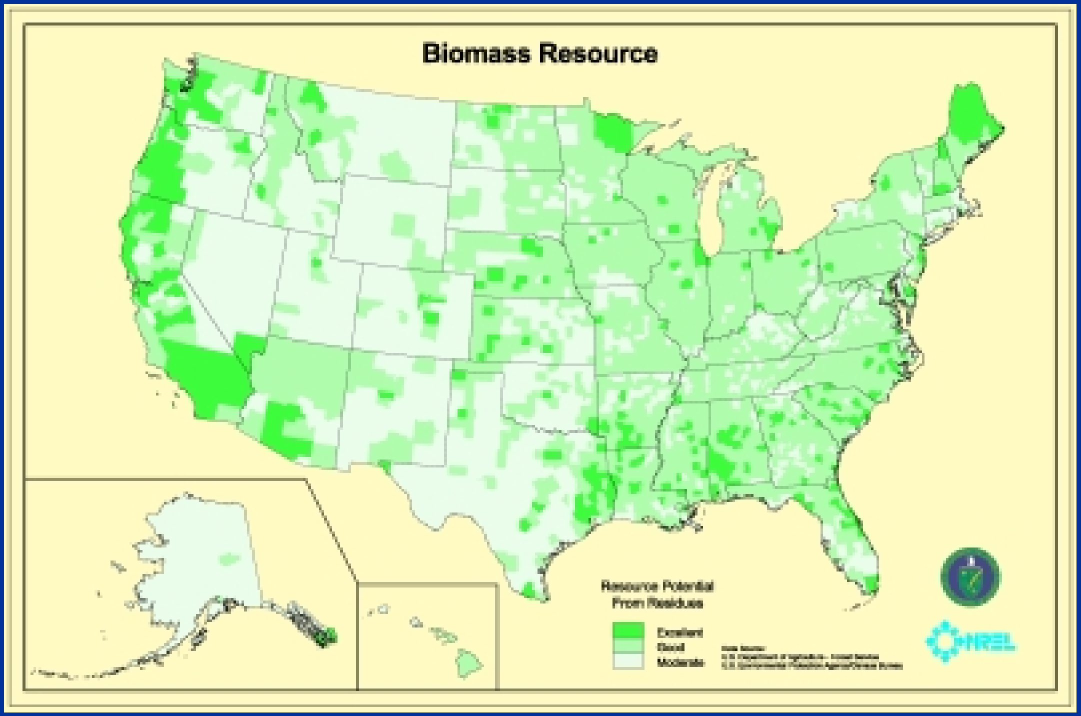
Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

[a] Wind speeds are based on a Weibull k value of 2.0

Bioenergy Resources

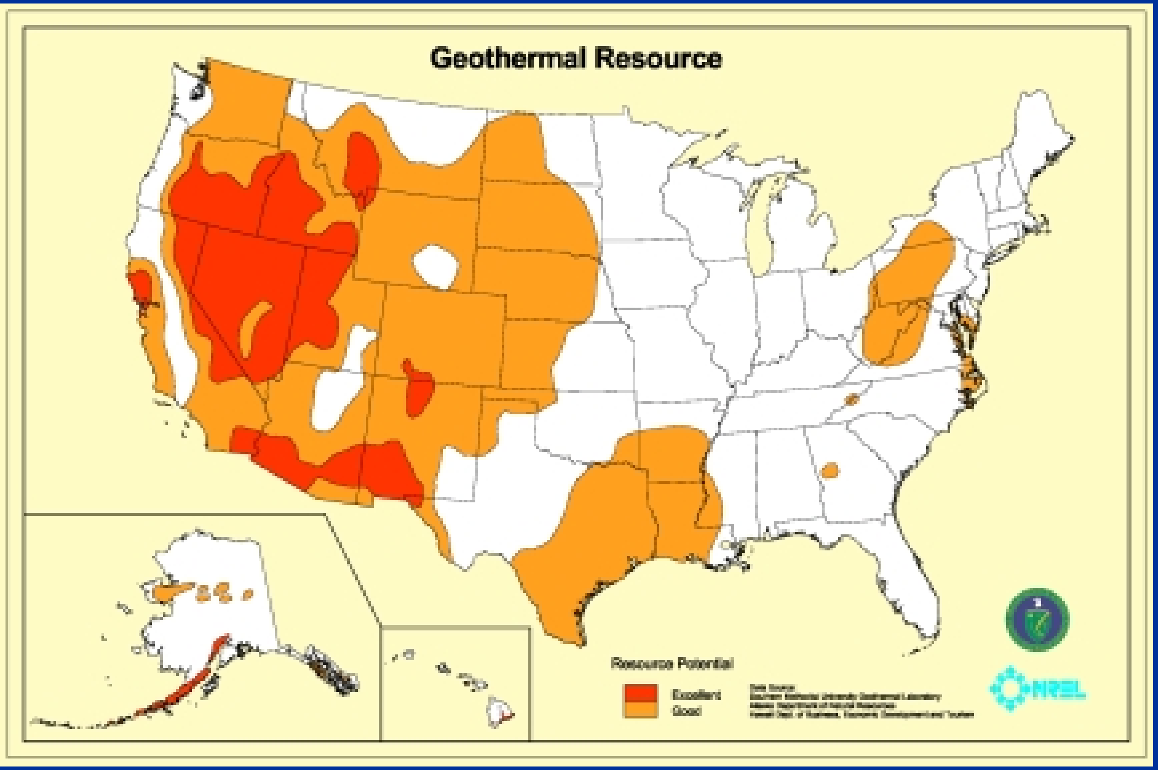
- County level
- Crop residues*
- Forest residues
- MSW



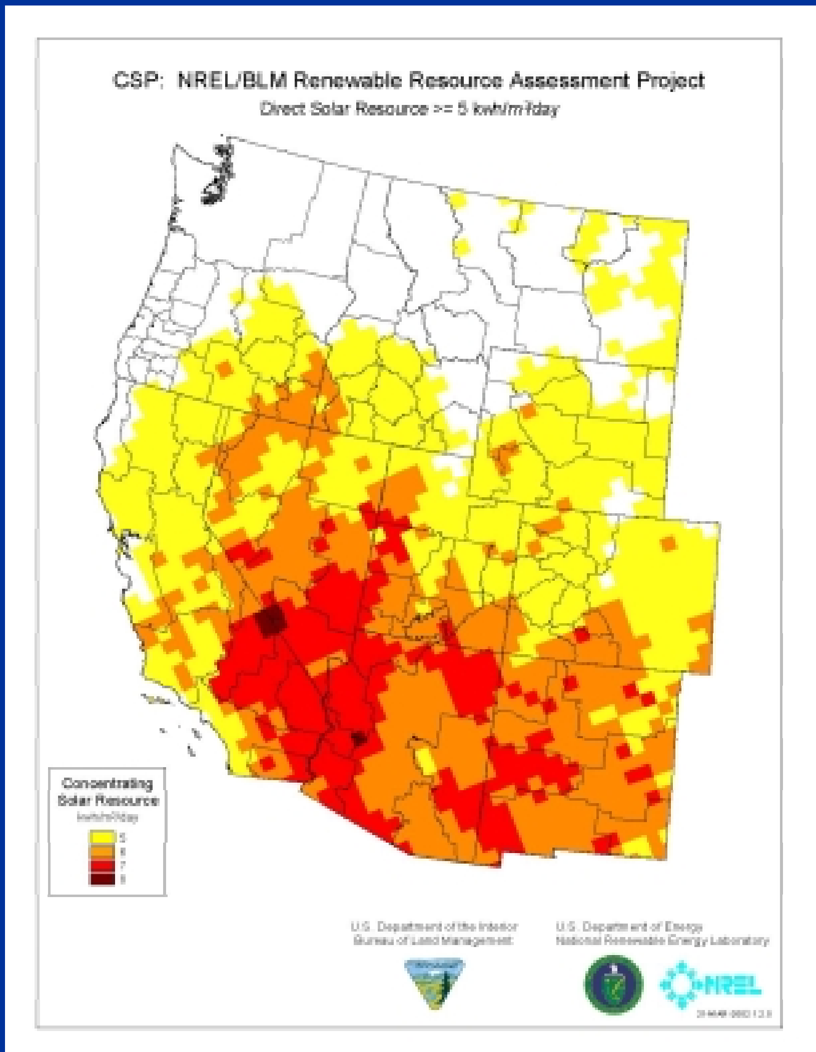
*Corn stover and wheat straw for 30 eastern states

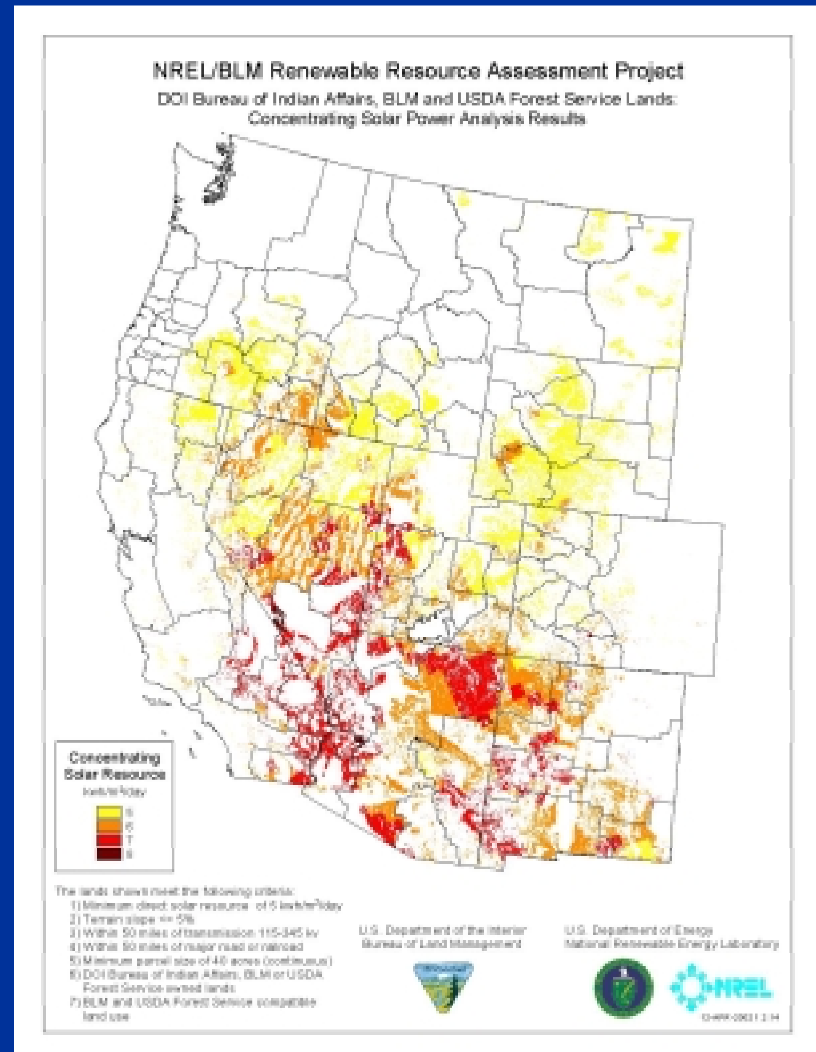
Geothermal Resources

- Source: SMU
- Based on surface temperature flow

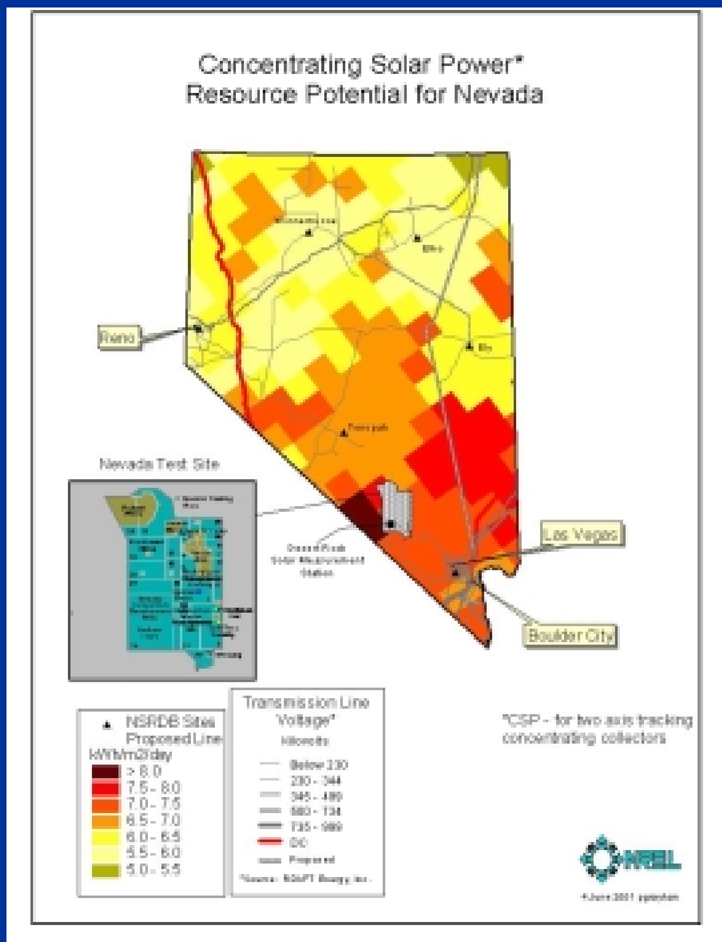


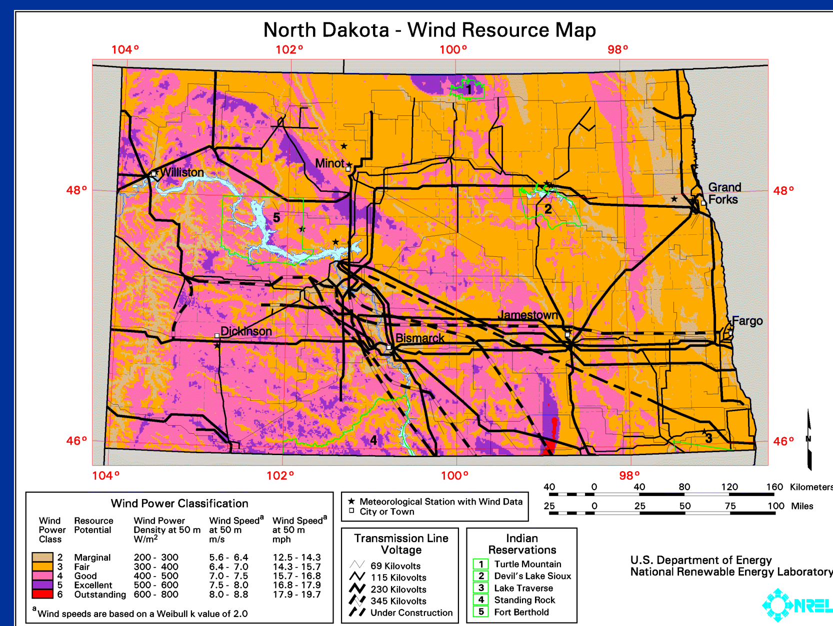
Integration into GIS





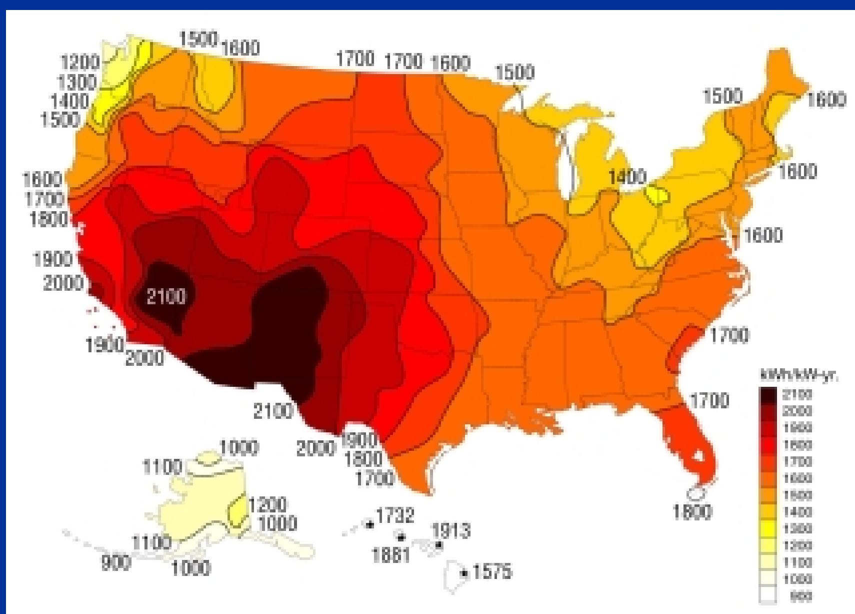
GIS Supports Analysis of Infrastructure Needed to Access Resources



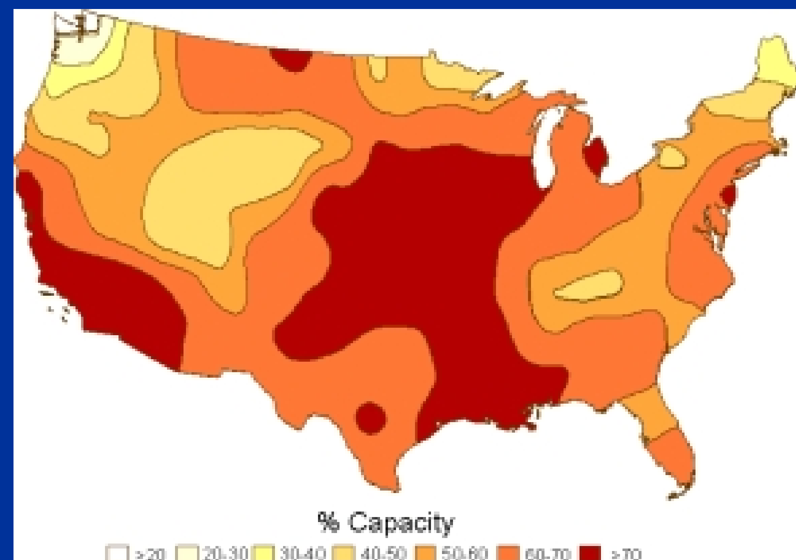


Examples of Value-Added Products

PV Energy kWh/kW-yr

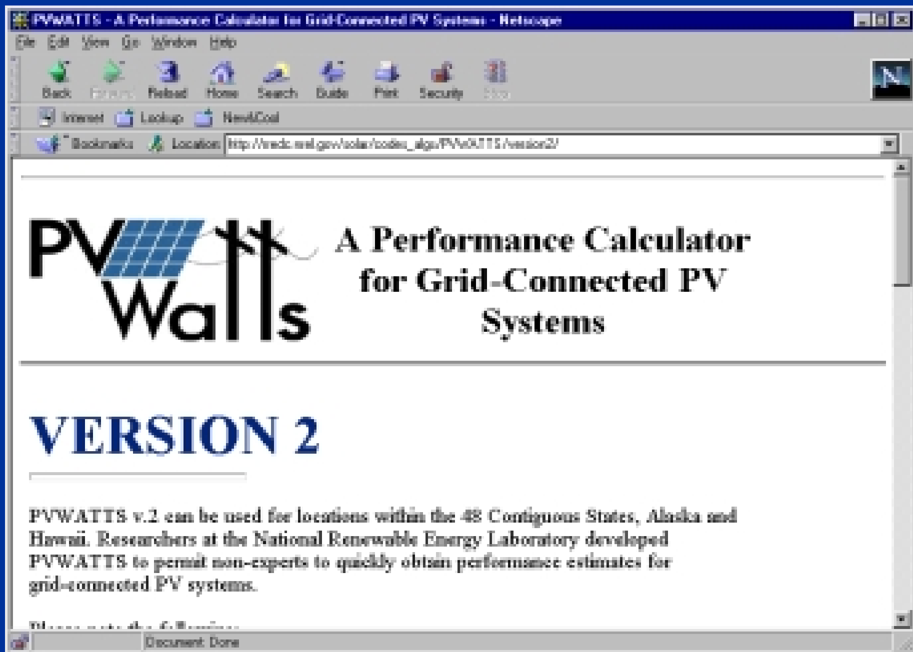


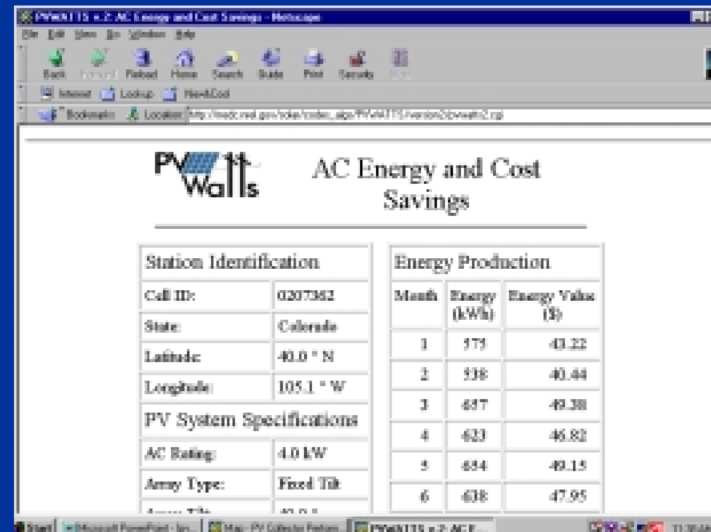
Effective Load Carrying Capacity

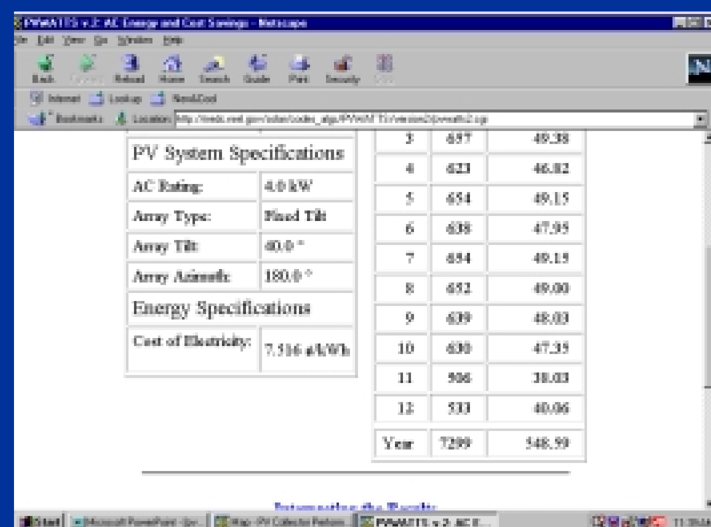


Source: Christy Herig (NREL) and Richard Perez (SUNY/Albany)

Estimating PV Production

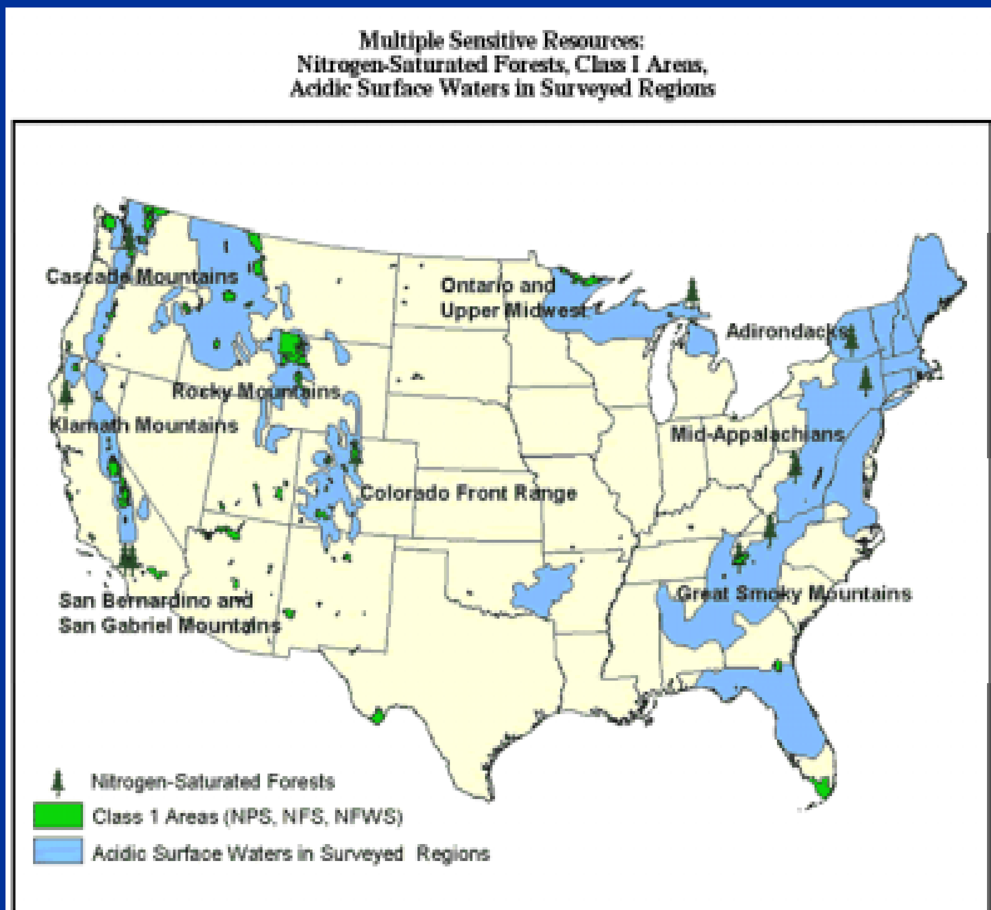


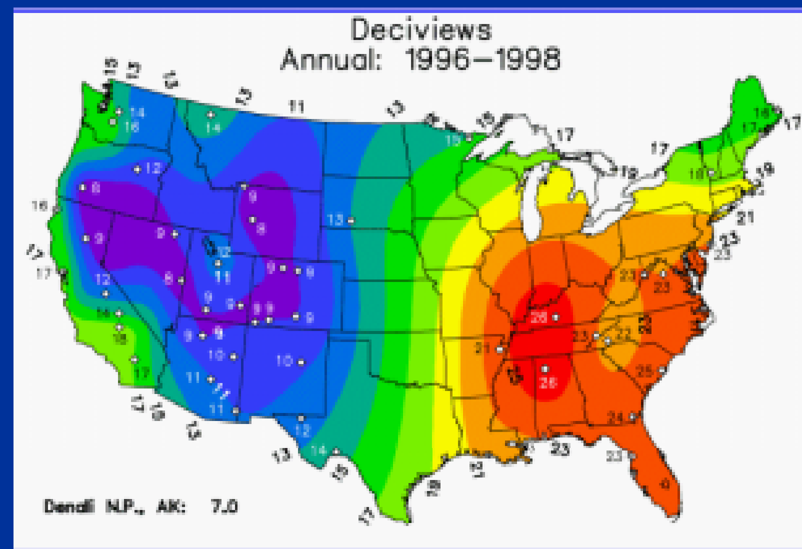


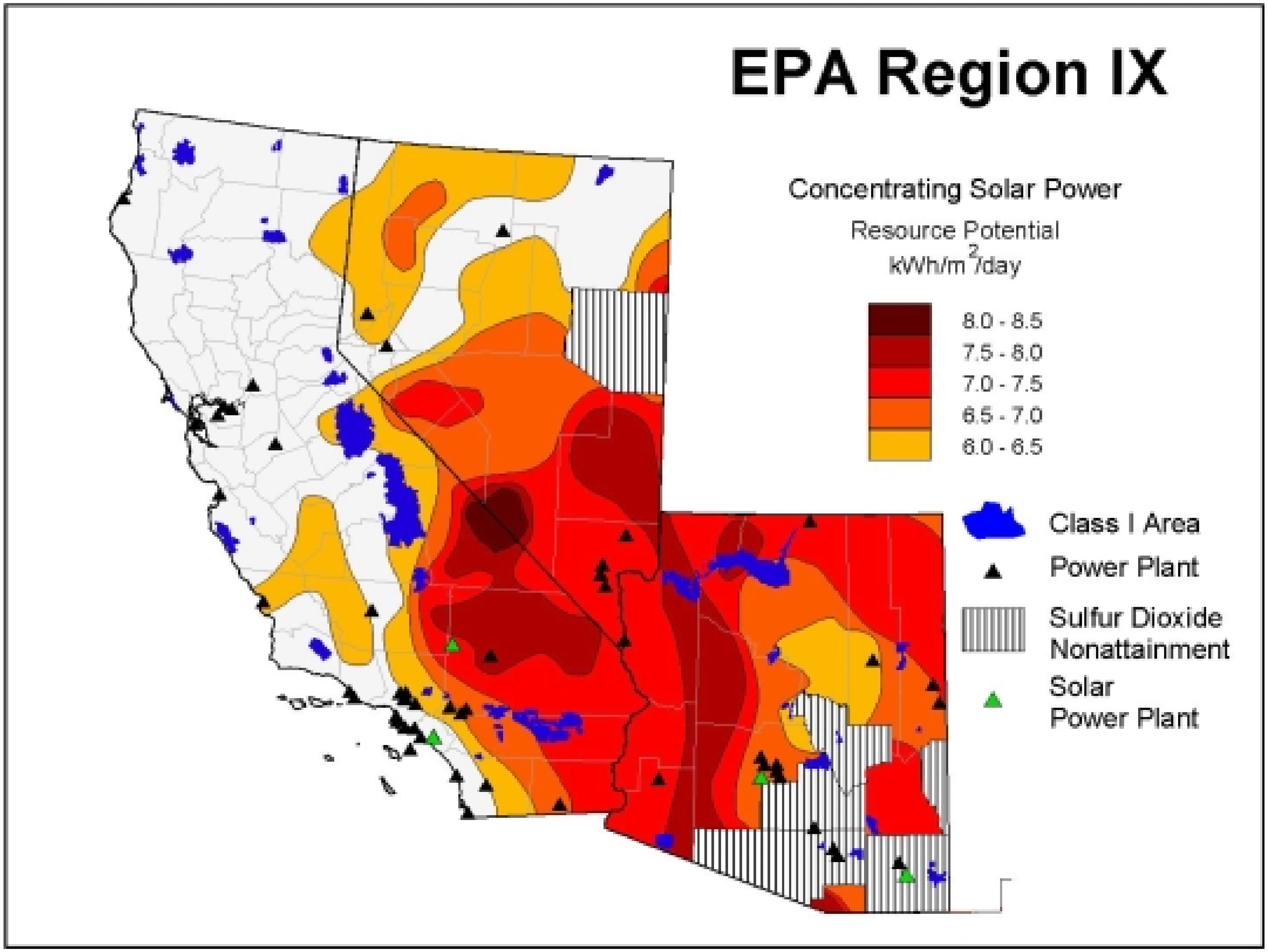


Output is monthly energy production and value of energy from grid-connected PV systems for any specified region

Application to Air Quality Mitigation Analysis






EPA Region IX
Concentrating Solar Power
Resource Potential
kWh/m²/day
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
Class I Area
Power Plant
Sulfur Dioxide Nonattainment
Solar Power Plant

Summary

- Renewable resources have strong temporal and geospatial characteristics
- Air quality mitigation strategies have a strong temporal and geospatial context
- GIS tools can be applied to assess mitigation strategies